

Concepts for Swarm System Software

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Problem



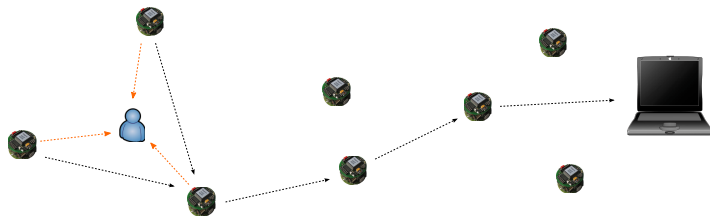


Missing Link - How to interact with the Swarm

- Programming the swarm directly is challenging
 - Requires precise domain knowledge of environment
 - Distribution is already error-prone
 - Incorporating real time and space makes it worse
- Thus, we argue for an adequate **abstraction**
 - Program **WHAT** you want and not **HOW** it is achieved
 - Maintaining transparencies: **Systemic view**
 - While introducing awareness

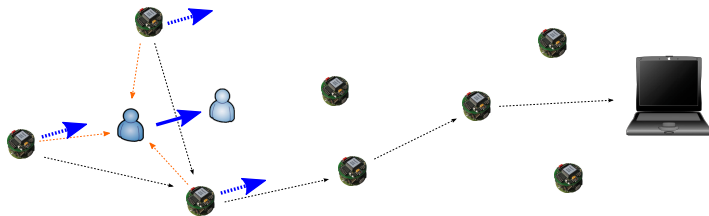
Example

- 3 sided observation
- Systemic description
 - 3 pictures (p_i) at time t of entity e
 - $\forall i \in \{0, 1, 2\} \exists j = (i + 1) \bmod 3 \mid$
 $dist(p_i, p_j) == d_1 \wedge dist(p_i, e) == d_2 \wedge$ (spatial)
 - $\forall i \in \{0, 1, 2\} \exists t_i = t$ (temporal)
 - $t, d_1, d_2 \in [..]$
- Neither quantitative nor qualitative aspects specified
- Solution will *emerge* implicit



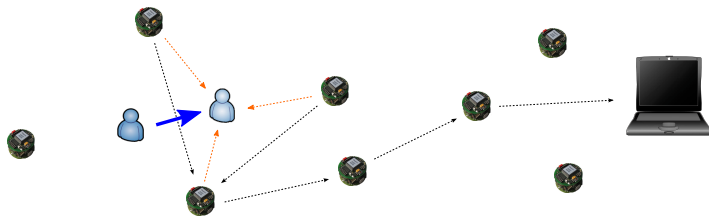
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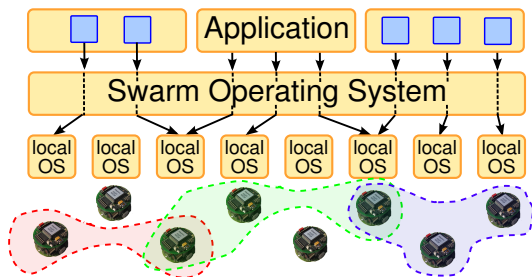


This requires ..

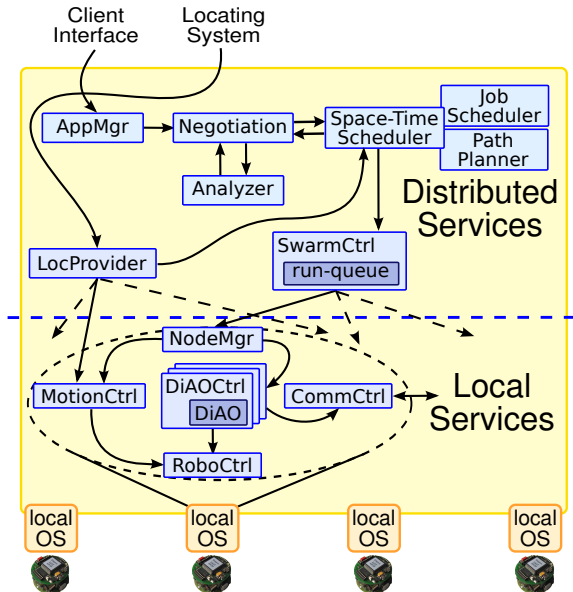
- A suitable programming abstraction
- An appropriate system software
- A space-time scheduler consisting of ..
 - A job scheduler
 - A path planner

How to manage such applications?

- Allow multiple applications to be executed
- Execution environment $\hat{=}$ virtual swarm
 - Resources may belong to 0, 1, ..., n virtual swarm(s)
 - Members of a virtual swarm may change over time
- Actions are defined on virtual resources
 - 1:1 mapping (1 virtual \rightarrow 1 physical)
 - 1: n mapping (1 virtual $\rightarrow n$ physical)
 - n :1 mapping (n virtual \rightarrow 1 physical)



Architecture



Conclusion

- Plethora of devices with heterogeneous ..
 - Hardware
 - (System) software
- Solution: Swarm operating system
 - Resource management
 - Space-time scheduling
- Programming abstraction
 - Transparency: Systemic view
 - Context awareness